**Savannah River Site**
**Solid Waste Management Department**
**Consolidated Incinerator Facility Project**
**Technical Support Training Program**

# CIF Safety Envelope (U)

# Study Guide

**ZITISD01**

**Revision 00**

Training Manager / Date

Engineering Manager / Date

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# REVISION LOG

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1. DOE-EM-STD-5502-94, *Hazard Baseline Documentation*, August 1994.

2. WSRC- SA-17, Safety Analysis Report, 200-H Area, Consolidated Incineration Facility, DOE Approval Copy, December 1994

3. WSRC-TR-96-0174, *CIF Hazards Baseline Downgrade*, June 1996.

4. WSRC-TR-96-0183, *Consolidation Incineration Facility Process Requirements*, July 1996.

5. WSRC-TR-96-0212, *Auditable Safety Analysis, Savannah River Site, Consolidated Incineration Facility*, Draft A, July 1996.

6. WSRC-TR-96-211, *Facility/Systems Design Description*

# LEARNING OBJECTIVES

## TERMINAL OBJECTIVE

**1.00** **DESCRIBE** the Extended Authorization Basis classification of CIF with regards to Radioactive and Non-radioactive hazards.

## ENABLING LEARNING OBJECTIVES

**1.01** **STATE** the classification of CIF in terms of hazard categorization.

**1.02** **STATE** the Extended Authorization Basis documents for CIF operations as a Radiological and Low (chemical) Hazard facility.

**1.03** **DESCRIBE** the hazards associated with the operation of CIF.

## TERMINAL OBJECTIVE

**2.00** **INTERPRET** the CIF Auditable Safety Analysis for proposed activities.

## ENABLING LEARNING OBJECTIVES

**2.01** DESCRIBE how the CIF Auditable Safety Analysis (ASA) supports the CIF safety envelope.

**2.02** **DESCRIBE** how the CIF Process Requirements (PRs) supports the CIF safety envelope.

**2.03** **DESCRIBE** how the operator is protected from accidents associated with the safety envelope.

**2.04** **LIST** the three Inventory Control Program limits which support the CIF Radiological/Low Hazard facility classification.

**2.05** For each of the five Auditable Safety Analysis (ASA) accident event categories, **DETERMINE** the associated consequence and risk.

**2.06** **EXPLAIN** why the CIF cannot experience events that produce significant radiological or non-radiological consequence to the public.

**2.07** **STATE** the bounding accident for CIF.

**2.08** **DESCRIBE** how nuclear criticality is prevented at CIF.

## TERMINAL OBJECTIVE

**3.00** DESCRIBE the purpose and use of the CIF Process Requirements.

## ENABLING LEARNING OBJECTIVES

**3.01** **DESCRIBE** the function of the CIF Process Requirements.

**3.02** **DEFINE** the following terms in accordance with the CIF Process Requirements:

a. Operable/Operability
b. Action
c. Surveillance Requirements (SR)
d. Immediately

**3.02** **DEFINE** the following modes in accordance with the CIF Process Requirements:

a. Operation
b. Warm Standby
c. Shutdown
d. Cold Standby

**3.03** **DETERMINE** the bases for equipment/conditions associated with CIF Process Conditions for Operations (PCOs).

**3.04** **DETERMINE** required actions and associated completion times for given CIF conditions using the Process Requirements.

**3.05** **DESCRIBE** the purpose and content of the Extended Authorization Basis Database.

# HAZARDOUS BASELINE DOWNGRADE

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|---|---|
| **1.01** | **STATE** the classification of CIF in terms of hazard categorization. |
| **1.02** | **STATE** the Extended Authorization Basis documents for CIF operations as a Radiological and Low (chemical) Hazard facility. |
| **1.03** | **DESCRIBE** the hazards associated with the operation of CIF. |

## Introduction

When the Consolidated Incinerator Facility (CIF) was initially proposed in the mid-1980s, the historical mission of the Savannah River Site (SRS) to produce nuclear materials was expected to continue indefinitely. The SRS mission of waste management was expected to continue to grow with the construction and operation of the Defense Waste Processing Facility (DWPF) and a variety of other solid and liquid waste treatment facilities. Estimates were made of the character and quantity of waste generated, or expected to be generated, from the various production and support facilities and site construction and maintenance programs. These estimates of new waste generation along with expected waste inventories from SRS sources were the basis for the CIF design input.

Since complete radionuclide characterization data was not available, the early CIF design and safety analyses were designed to provide flexibility. The Hazards Assessment Document and the Safety Analysis Report were developed as a “backwards fit” to a Hazard Baseline of Hazard Category 3 (nuclear), Low Hazard (chemical) facility. The “backwards fit” process did not require full radionuclide/chemical characterization data, but rather established inventory controls to ensure CIF would remain within prescribed limits. The “backward fit” classifications also established the baseline for facility design criteria (wind speed, seismic, etc.), the level of safety documentation and the functional classification of components in the facility.

Since the development of the initial facility design, data which impacts the Hazards Baseline has emerged in three key areas: waste stream characterization, radiological controls, and plant operating experience.

Information related to the waste feed streams to be processed at CIF has become more firm. The Site Treatment Plan which was approved in 1995 specifies those streams to be sent to CIF. The Final Environmental Impact Statement for Savannah River Site Waste Management was also issued in July, 1995. Pre-treatment of waste streams is now recognized as a necessity for most waste streams and provides an opportunity for improved characterization. With firmer data available, exposure calculations under normal operation, abnormal operation and accident conditions can be assessed for specific waste streams. Radionuclide inventories can also be predicted and compared to DOE guidance.

At CIF the incineration of hazardous wastes is complicated by the radiological aspects of the waste streams. The preparation and implementation of modern RADCON (radiological control) practices and procedures at CIF have resulted in a number of facility alterations including relocation of monitors, improved sample points, and contamination control huts. In some areas of the facility ALARA (as low as reasonably achievable) considerations will be more restrictive than the current inventory control limits. An example of ALARA concerns is the blend tanks in the Tank Farm area of CIF. If the blend tanks are filled with a waste stream that contains radionuclide activity near the Hazard Category 3 inventory limit, direct radiation rates in the immediate vicinity could exceed 100 mrem per hour. This high radiation rate is not tolerable under current radiological control practices and shielding is cost prohibitive.

With the completion of the Pre-Trial Burn period, CIF has gained invaluable operating experience. In addition, experienced personnel from other incinerator locations have been brought in to aid in the facility startup. Technical reports which reviewed the technical issues related to the initial Pre-Trial Burn heightened awareness that liquid waste blending for viscosity and BTU content control would be a part of CIF burn planning.

The Hazard Baseline for CIF is a function of the waste stream source terms and the operational characteristics (permit limits, feed rates, inventory control, equilibrium levels, ALARA constraints, blending, etc.). In order to determine the Hazard Baseline based on current facility information, Westinghouse utilized the guidance provided in DOE-EM-SDT-5502-94, *Hazard Baseline Documentation.*

The standard states that "*there are three primary regulatory thresholds or levels used for determining the appropriate hazard baseline documentation:*

- *Hazard Category 3 per DOE 5480.23, <u>Nuclear Safety Reports</u>, and DOE-STD-1027-92, <u>Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23</u>;*

- *29CFR1910.119, <u>Occupational Safety and Health Standards</u>, <u>Process Safety Management</u>; and*

- *40CFR302, <u>Designation, Reportable Quantities and Notification</u>."*

The Hazard Baseline Documentation standard further states that facilities below the Hazard Category 3 threshold inventories but above 40CFR302 reportable quantity (RQ) inventory limits are considered Radiological Facilities.

The safety documentation requirements vary with the hazard thresholds. These thresholds are based on the radionuclide or chemical inventory contained within a facility segment. These requirements are summarized in Table 1, Hazard Baseline Documentation Groupings.

| NUCLEAR FACILITIES | |
|---|---|
| Hazard Category | Document Required |
| Category 1/2/3 | SAR (5480.23)<br>TSR (5480.22)<br>HASP (1910)<br>USQ (5480.21) |
| NON-NUCLEAR FACILITIES | |
| Hazard Category | Document Required |
| High<br>Moderate (EPRG-3)<br>Low (EPRG-2) | Safety Analysis or ASA (.1B) and a HASP (1910) |
| RADIOLOGICAL FACILITY | |
| | Document Required |
| | Auditable Safety Analysis |
| OTHER INDUSTRIAL FACILITIES | |
| | Document Required |
| with Hazardous Waste | HASP (1910) |
| Standard Hazards | OSHA |

**Table 1, Hazard Baseline Documentation Groupings**

The CIF contains three facility segments: the main building (box handling, incinerator, and control room), the tank farm, and the propane storage tank. As previously was discussed, the current CIF Hazard Baseline was "backwards fit" as a Hazard Category 3 and Low (chemical) Hazard. Inventory control limits were established accordingly for each facility segment. This classification requires a 5480.23 Safety Analysis Report (SAR). The CIF SAR (WSRC-SA-17) was approved by DOE-SR in May, 1995.

In May, 1996, DOE and Westinghouse initiated a review of the Hazard Baseline of CIF based on current facility information. These assessments, consisting of a series of scoping assessments, were performed to ensure that a lower Hazard Baseline (radionuclide inventory limits) would not unduly restrict CIF operations. The assessments considered:

- The radionuclide content of waste streams entering CIF,
- Radionuclide buildup in the process,
- Potential impacts to the existing Waste Acceptance Criteria, and
- Impacts to the chemical analyses

### Hazard Baseline Review Conclusions

The assessments performed demonstrated that CIF can, and will, be operated such that the Hazard Category 3 threshold is not exceeded. Incoming waste stream inventories and ash buildup inventories will not be unduly restricted by the lower Hazard baseline. Therefore, the Hazard Baseline for CIF will be downgraded to a "Radiological Facility." The facility will remain classified as a Low (chemical) Hazard facility.

## Authorization Basis Transition

Hazards Baseline documentation requirements still exist for CIF. Radiological facilities are required to develop an Auditable (defendable) Safety Analysis (ASA). This analysis is similar to a SAR but with much reduced content and requirements. In addition, radiological facilities with hazardous waste activities require the development and maintenance of a Health and Safety Plan (HASP).

DOE and Westinghouse personnel have worked together to develop guidance for the transition of CIF authorization basis documentation from the existing Safety Analysis Report to a HASP and ASA. In keeping with DOE guidance, CIF will develop a single document which includes requirements for the HASP as delineated in WSRC Manual 20Q, Hazardous Waste Operations. The ASA portion of this document will:

- Systematically identify potential hazards
- Describe and analyze the adequacy of measures taken to eliminate, control, or mitigate these hazards
- Analyze the risks associated with potential accidents

The CIF Technical Safety Requirements (TSR) will be replaced by limiting conditions defined in the HASP/ASA and implemented through the Process Requirements. The existing SAR and TSR will remain in effect until a formal notification to proceed is received from DOE-SR. At that time, the CIF SAR and TSR will be archived.

Westinghouse will define the HASP/ASA as the Authorization Basis for CIF operations. The existing Unreviewed Safety Question Determination process will be evoked by the ASA to ensure the ASA is maintained and that proposed activities which could impact inventory controls are properly evaluated.

# INTRODUCTION TO SAFETY ENVELOPE

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|---|---|
| **ELO 2.01** | **DESCRIBE** how the CIF Auditable Safety Analysis (ASA) supports the CIF safety envelope. |
| **ELO 2.02** | **DESCRIBE** how the CIF Process Requirements (PRs) supports the CIF safety envelope. |
| **ELO 2.03** | **DESCRIBE** how the operator is protected from accidents associated with the safety envelope. |
| **ELO 2.04** | **LIST** the three Inventory Control Program limits which support the CIF Radiological/Low Hazard facility classification. |

## Background

A safety envelope is an operating environment in which we can be reasonably assured of not harming site personnel, the public, or the environment. This operating environment starts with the original design and safety features, and includes the administrative controls placed on the operation of equipment. An Auditable Safety Analysis (ASA) is the foundation for the safety envelope. The ASA analyzes the initial facility design and mandates the required safety features and administrative controls required to safely operate the facility. Controls are implemented through the Process Requirements and procedures.

The Process Requirements establish the ground rules for operating the CIF facility. These requirements are further amplified within the facility operating procedures. Operating within the limits of the Process Requirements and approved operating procedures helps maintain the safety envelope. If an accident does occur, emergency procedures provide steps to return the facility to a safe condition. Operator training on the use and bases of the Process Requirements and procedures is a vital element in the protection of the safety envelope.

No amount of engineering guarantees the safety of equipment that is operated incorrectly. The operator is not protected from accidents through reliance on numerical limits. Therefore, the human element of how we operate the facility is a crucial aspect of the safety envelope. The operator is protected through training and reliance on safety management programs such as the following:

- Operational Safety Program
- Radiation Protection Program
- Hazardous Material Protection Program
- Emergency Preparedness Program
- ALARA program

As long as the facility Inventory Control Program and site safety management programs are implemented and adhered to, as specified in the facility Process Requirements, there is no undue risk to facility personnel, other onsite personnel, or the public from potential accidents at the CIF.

From an operations standpoint the operating envelope concept should be an ingrained part of every facet of the job. Prior to performing any action, operators should be aware of the expected results and potential consequences of that action. Operator knowledge, training, concern for safety and attention to detail are all integral parts of the safety envelope.

## Auditable Safety Analysis (ASA)

As a Radiological facility, the CIF is required to have an ASA that systematically identifies hazards and that describes and analyzes the adequacy of measures taken to eliminate, control, and/or mitigate the hazards. The ASA addresses the following aspects of the facility safety analysis that relate directly to the protection of facility personnel, other onsite personnel, the public, and the environment:

- Site characteristics have been thoroughly evaluated as they relate to the CIF
- The principle design criteria for the facility address identified hazards
- The analysis of operations indicated that all specific hazards have been systematically identified and evaluated under normal, abnormal, and accident conditions.

The Analysis of Operations for CIF presents the systematic identification, evaluation, and control of hazards associated with the operation of the facility as well as the spectrum of postulated credible events involving those hazards. A postulated event is considered credible if the frequency of occurrence is 1.00E-06/year or greater.

Three types of postulated events: normal operational events are considered: Normal Operational Events, Abnormal Operational Events (AOEs) and Accidents. The Analysis of Operations section of the ASA:

- Demonstrates that all hazards have been systematically identified
- Documents the features established to prevent, control, or mitigate the hazards
- Demonstrates that a sufficiently broad spectrum of initiating events has been considered
- Categorizes the events as normal operational occurrences, abnormal operational occurrences, or accidents
- Indicates the expected frequency of the events
- Indicates the consequences and risks associated with the events

## Health and Safety Plan (HASP)

As a Radiological/Low Hazard facility, the CIF is required to have a health and safety plan that discusses programs for the identification, evaluation, and control of safety and health hazards for the purpose of employee protection and that defines emergency response requirements. The CIF Health and Safety Plan is provided as Appendix 1A to the ASA. In addition, this plan addresses, as appropriate, site analysis, engineering controls, maximum exposure limits, hazardous waste handling procedures, and uses of new technologies. The HASP discusses programs that identify, evaluate, and control safety and health hazards for the purpose of employee protection.

## Inventory Control Program (ICP)

The maximum hazards for the CIF are defined by the facility hazards classification, which is maintained through the facility Inventory Control Program. The Inventory Control Program controls the radioactive, hazardous, and fissile material inventories in the facility, to levels that establish the CIF as a Radiological/Low Hazard facility. Hazardous wastes at the CIF are in the form of:

- Solid waste received in the box handling area
- Liquid waste received in the tank farm
- Process liquid (containing wet ash and tritium) in tanks in the offgas area
- Wet ash in the ash receiving tank in the ashout area
- Ashcrete (containing wet ash solidified in the cement)
- Blowcrete (containing process liquid from the offgas area solidified in cement)
- Ash plated out in the inside of process components.

The Inventory Control Program contains the following limits:

- The maximum radiological inventory in a facility segment is less than the Hazard Category 3 threshold level specified in Department of Energy (DOE) Standard 1027-92. The Hazard Category 3 threshold values for radionuclides represent the levels of material that, if released, would produce a dose less than 10 rem at 30 meters based on a 24-hour exposure. A Hazard Category 3 facility by definition cannot release the quantities of materials that could threaten workers at adjacent facilities, the public, or the environment.
- The maximum nonradiological inventory in a facility segment is less than the quantity that would result in a maximum 15-minute airborne concentration for each chemical at 100 meters due to any accident of one Emergency Response Planning Guideline (ERPG)-2 equivalent value.
- The mass of fissile material accumulated in the facility is limited to 624 grams of equivalent U-235 to ensure that criticality is not a credible event for the life of the facility.

These Inventory Control Program limits are implemented through the facility Process Requirements.

## Applicable Permits

Among the list of permits applicable to the CIF are:

- RCRA Hazardous Waste
- NESHAP Radionuclide Emissions
- NESHAP Benzene Fugitive Emissions
- SCDHEC Air Pollution Control Permit
- Air Quality Control Permit

## Process Requirements (PRs)

In general, process requirements define the conditions, requirements, and limits of facility operations in the following areas:

- Safety
- Environmental protection
- Product quality assurance
- Production outage minimization
- Production capacity protection
- Flammable atmosphere or explosive compound prevention
- Existing technology limitations
- Employee protection

The CIF Process Requirements document was developed based on a review of the safety analysis and environmental permits for the facility. This review resulted in the establishment of operating limits, surveillance requirements, and administrative controls found in the Process Requirements. The operating limits and surveillance requirements for the CIF are grouped into the following categories:

- Flammability control and monitoring
- Inventory and criticality control
- Level/leak control
- Environmental emissions and radiation monitoring
- Operational controls
- Administrative controls

The inventory and criticality control limits form the basis of the facility Inventory Control Program, which consists of the following program elements listed in the administrative controls section of the Process Requirements:

- CIF Process Requirements that define Inventory Control Program requirements

- CIF Waste Tracking System (a computer code) or manual system
- CIF Waste Acceptance Criteria
- CIF procedures that support the Inventory Control Program

The administrative controls in the Process Requirements also support the various operating limits and surveillance requirements, as necessary, and specify additional requirements that are programmatic in nature.

# ASA ANALYSIS OF OPERATIONS

| | |
|---|---|
| **2.05** | For each of the five Auditable Safety Analysis (ASA) accident event categories, **DETERMINE** the associated consequence and risk. |
| **2.06** | **EXPLAIN** why the CIF cannot experience events that produce significant radiological or non-radiological consequence to the public. |
| **2.07** | **STATE** the bounding accident for CIF. |
| **2.08** | **DESCRIBE** how nuclear criticality is prevented at CIF. |

## Identification of Hazards and Controls

Facility segments are divided into unit operations and each unit is analyzed for the hazards listed below:

- Fires
- Explosions
- Nuclear Criticality
- Natural Phenomena
- External Events
- Radioactive and Chemical Releases
- Direct Radiological Exposure

Industrial safety and hygiene hazards are discussed separately. The above listed hazards are evaluated for the following:

- Causes
- Systems that prevent occurrence
- Systems that detect occurrence
- Systems that mitigate the consequences
- Consequences

The result of this analysis provides a hazard summary that describes the safety systems and features (both engineered and administrative) established to prevent, control or mitigate the Hazards applicable to CIF.

## Normal Operations

The protection of facility personnel, other on-site personnel, the public and the environment on a day to day basis during normal operation is accomplished through the use of requirements and controls.

The controls in place at CIF are in the form of federal and state requirements and permits. Satisfaction of Federal requirements include:

- *Clean Air Act* requirements regulating the Emission of radionuclides
- *Resource Conservation and Recovery Act* concerning Hazardous Waste

The satisfaction of State requirements include:

- Air Pollution Control Regulations and Standards
- Hazardous Waste Management Regulations

Permits required for the construction and operation of CIF include:

- National Emissions Standards for Hazardous Air Pollutants Permit
- SCDHEC Air Pollution Control Permit
- RCRA Part B Permit
- National Pollutant Discharge Elimination System Permit

The Inventory Control Program (ICP) limits total radiological and chemical inventories. This is implemented through the Process Requirements.

Site Safety Programs provide safety assurance during all aspects of facility operations. Programs include:

- Radiation Protection Program
- Hazardous Material Protection Program
- Operational Safety Program
- Training Program
- ALARA Program
- Lessons Learned Program

The responsibility for industrial safety and hygiene practices that prevent workplace injuries and protect personnel health lies within the individual and line management. Administrative barriers are in place to protect CIF staff from the adverse effects of non-radiological hazards. The barrier must fail or be compromised before ill effects are experienced by the staff. These administrative barriers include:

- Approved Operating Procedures
- Approved Administrative Procedures
- Approved Maintenance Procedures
- Approved Training Programs (including Certification and Qualification)
- Formal Safety Programs (including specialized training for operating and support staff and reviews and inspections by safety staff)

- Engineered safety features such as shields, guards, interlocks, and insulation
- Operating features such as equipment redundancy and functional testing
- Facility features such as ventilation, fire protection/suppression, and illumination

## Abnormal Operational Events (AOE)

An AOE is defined as any loss of function (including operator error) of a safety or support system that does not have a significant impact outside of the facility within or beyond the site boundary. The worst case consequence of an AOE is:

- Partial or total shutdown
- Industrial safety or hygiene hazard
- Personnel contamination

### AOE Evaluation Methodology

AOE's were identified and evaluated using the following steps:

- CIF was divided into systems
- Each system was analyzed for postulated failures
- Each failure including consequences was assumed to be the AOE
- Consequences for each AOE were determined qualitatively
- Corrective actions for each AOE were identified

AOPS were generated to mitigate the consequences of AOE's and facility personnel are protected through implementation of site safety programs such as:

- Radiation protection
- Hazardous material protection
- ALARA

## Accident Analysis

The accident analyses information contained in the ASA presents analysis of events initiated by internal or external occurrences that have the potential to produce significant consequences at CIF. Any event that has a significant impact outside of the facility within or beyond the site boundary is addressed as an accident.

The following events were analyzed in detail:

- Explosions
- Fires
- Criticality
- Low-Energy Liquid Releases (LELRs)
- Natural Phenomena

Each event is analyzed in terms of causes, detection, frequency of occurrence, consequences, and risk. A quantitative summary of event frequencies is provided while a qualitative summary of event frequencies, consequences, and risk is provided. Consequence levels are in terms of the hazards inherent to the Radiological/Low Hazard facility classification with high consequences referring to the maximum consequences associated with the inherent hazards. Risk is based on frequency of occurrence and consequence. Consequence and risk are not evaluated for incredible accidents.

As a Radiological/Low Hazard facility, which by definition has lower hazards than a Hazard Category 3 facility, the CIF cannot experience events that produce significant radiological or nonradiological consequences to the public. Therefore, consequences for postulated accidents at the CIF are described qualitatively. Consequences for accidents at the CIF are assumed to affect only the facility and the area immediately adjacent to the facility. Consequences are given in Table 2, Factors Determining Consequence Levels, based on the inventory and airborne release fraction associated with the event.

| Consequences | Inventory Release Fraction | Airborne Release Fraction |
|---|---|---|
| Very Low | Only a fraction of the contents of a single vessel | Relatively small |
| Low | The contents of a single vessel at most | Relatively small |
| Medium | Only a fraction of the inventory in the affected facility segment | Relatively large |
| High | Most, if not all, of the inventory in the affected facility segment | Relatively large |

**Table 2 Factors Determining Consequence Levels**

Of the following credible accidents, large fires were determined to be the bounding. These determinations were made based on the source term being within the limits of the Inventory Control Program identified in the Process Requirements. Table 3, Qualitative Summary of Event Frequencies, Consequences, and Risks, summarizes the ASA accident analysis.

| Event | Scenario/Location | Frequency | Consequence | Risk |
|---|---|---|---|---|
| Explosions | Backhoe housing<br>Tank farm drum storage<br>Rotary kiln (worst case)<br>Others | Low<br>Medium<br>Low<br>Incredible | Medium<br>Low<br>Medium<br>N/A | Low<br>Low<br>Low<br>N/A |
| Fires | Small<br>Large (bounding event) | Medium<br>Low | Medium<br>High | Medium<br>Medium |
| Criticality | Deterministic | Incredible | N/A | N/A |
| LELRs | Small<br>Large | High<br>Medium | Very Low<br>Low | Low<br>Low |
| Natural Phenomenon | Earthquake<br>High-velocity straight winds | Low<br>Medium | Medium<br>Low | Low<br>Low |

**Table 3 Qualitative Summary of Event Frequencies, Consequences, and Risks**

## Explosions

Four factors must be present for an explosive event to occur. These include a source of fuel, a source of oxygen or other oxidizing compound, a source of ignition or heat, and an enclosed or semi-enclosed area in which an explosive atmosphere can accumulate. If the first three factors exist without the fourth, then the fire triangle is present and a fire hazard exists.

For each possible enclosure at CIF, the presence of fuel, oxygen, and ignition sources were identified. In any enclosure where all three were present, an accident scenario was developed. As a result, eleven explosion scenarios were developed and analyzed. The frequency of occurrence for each scenario was determined quantitatively. Any scenario that produced a frequency of occurrence of greater than once in a million years was considered as credible. Further analysis was then performed on credible events to determine consequence and risk associated with the accident.

Of these scenarios, only explosions in the rotary kiln, drum storage area, and backhoe housing were determined to be credible. Of these, the rotary kiln explosion was determined to be the worst case event.

### Explosions in the RK and SCC

The RK and SCC are designed to operate under conditions of high temperature with a continual flame atmosphere. The presence of a flame atmosphere and excess combustion air ensures that the waste introduced into the kiln will burn completely under normal operating conditions. In addition, they also ensure that combustible or explosive gases do not normally build up in the kiln or downstream in the SCC and in the offgas system.

Under certain special or upset conditions, it is possible to accumulate an explosive atmosphere in or around the kiln area. The five most likely RK explosion scenarios are presented in the ASA. Of these the worst case explosion accident at CIF is discussed below. Worst case refers to the degree of margin remaining to the limits associated with authorization basis.

## Detection of an Explosion Hazard in the Rotary Kiln

There are oxygen and carbon monoxide sensors located within the RK that will detect the presence of flammable vapors or insufficient oxygen. These sensors require the response of an operator during an alarm signal. The proper operation of these sensors is important to the prevention of explosive conditions in the RK. Process requirements ensure the operability of these systems.

### Sequence

Failures occur which result in a total loss of air flow through the RK/SCC. Latex in the previously injected solid waste decomposes and flammable isoprene vapors form a fuel-rich vapor mixture. The vapor buildup prevents additional air entry during early stages of cooldown. During the continued cooldown vapor contraction occurs allowing air to enter the RK/SCC. As the temperature decreases below the auto-ignition temperature, a pocket of air and isoprene accumulates near stoichiometric conditions. This mixture increases until it contacts a local hot spot and is ignited.

### Frequency

The overall frequency for this accident is estimated to be 1.5E-04/year. The probability of a fuel source and an oxygen source presence during this event are both 1.0. Natural events will lead to a vapor formation and air entering the kiln upon cooldown. Latex decomposes into isoprene vapors and cooldown causes contraction of vapors and air inleakage.

An ignition source could be available from a local hot spot on the kiln wall or from remaining hot embers if the RK drive fails and allows these embers to accumulate.

A loss of total air flow leading to the availability to form a vapor cloud is the limiting condition for this accident. The probability of this occurring is one in 1,000 years.

## Analysis of Effects and Consequences of an Explosion in the Rotary Kiln

An explosion in the RK would result in a radiological and nonradiological release to one of several areas. These areas would include the ram feed area, the kiln enclosure area, or the ash processing area. The instantaneous pressure buildup could result in damage to the RK, SCC, backhoe housing, or offgas system.

An explosion in the RK would release radioactive and non-radioactive material in the form of airborne ash. This release could occur into the ram feed area, kiln enclosure, or the ash processing area. The maximum combined loose ash, placed ash, and ash deposited in the two HEPA filters involved in the explosion was assumed to be 242 pounds. With this inventory, the maximum exposure calculated to be received was well within the authorization basis limits.

The consequences associated with this event are medium based on only a fraction of the segment inventory being involved and a relatively large release fraction. Risks associated with the RK explosion are Low based on a low frequency of occurrence and a medium consequence.

## Fires

While explosions have the ability to create high localized damage, fires have the ability to generate damage over a larger area. As a result, fires prove to be the bounding accidents for radiological and nonradiological consequences.

The Design Basis Fire affects only one segment of CIF. It is an incredible event for the entire CIF to be involved in one fire.

### Causes of Fires

The primary causes of fire at CIF can be expected to be welding, electrical shorts, smoking, and friction. Materials in contact with hot process equipment, lightning, lighting, and explosions are expected to account for the remainder of the fires in CIF.

### Detection of Fires

Fires are detected by automatic detection systems (e.g., smoke detectors, ultraviolet detectors, and activation of sprinkler heads) and occupants of CIF.

### Frequency of Fires

The determination of frequency is based on two types of fires: small fires and large fires. As expected, the small fire occurrence frequency, 3.33E-01 events per year, is larger than that of large fires, 2.34E-02 events per year.

### Analysis of Effects and Consequences of Fires

The consequences of fires are potential monetary losses, injuries and death of personnel, and radiological and nonradiological exposure. The consequence of a large fire is related to the amount of inventory involved. A large fire involves most if not all of the inventory in a segment and fires represent a large release fraction. The result is High consequence for a large fire. A small fire involving only a fraction of the inventory in a segment with a large release fraction results in a Medium consequence.

For both of the facility segments analyzed for fire, the maximum radiological and nonradiological consequences are bounding in the ASA. That is, an individual at 30 meters could receive close to the maximum of 10 Rem whole body exposure in 24 hours following either of these two fires. Likewise, the maximum individual nonradiological exposure at 100 meters due to either of these two accidents could be close to the IDLH value in 15 minutes.

### Analysis of Risk for Fires

The risk presented by fires is the highest of any other single event at CIF. The low frequency of a large fire related to its high consequence yields a medium risk to CIF. Small fires having a higher frequency of occurrence present medium consequence and yields medium risk also. Large and small fires present the same risk at CIF.

## Nuclear Criticality

### Background

The criticality analysis for CIF showed criticality to be an incredible event at the facility, but we do not discount the hazard. It must be prevented by administratively controlling the fissile material inventory. The Inventory Control Program requires CIF personnel to track the fissile material inventory in the CIF and perform facility cleanouts when fissile limits are reached.

### Causes of Nuclear Criticality

The maximum safe mass limit at CIF could be caused by failing to accurately maintain the fissile material inventory or failing to perform a facility cleanout after the fissile material limit has been reached on two consecutive occasions.

### Detection of Nuclear Criticality

Since exceeding the maximum safe mass at CIF is an incredible event, detection of a criticality event at CIF is not required. Therefore, no criticality alarm system is installed.

### Frequency of Nuclear Criticality

The frequency of a criticality event at CIF was determined to be 6.75E-07 events per year. This frequency is based on the assumption that CIF personnel will track the fissile material inventory and will perform a facility cleanout when necessary.

To account for human errors, fissile material control equations will be used by the CIF operators to limit the total fissile material inventory in CIF to 624 grams of equivalent U-235. A facility cleanout will be performed when this limit is reached. The CIF Process Requirements provide guidance on this limit.

### Analysis of Effects, Consequences, and Risks of Nuclear Criticality

Since the probability of a criticality event at CIF is an incredible event, the consequences and risks associated with this event were not evaluated.

Based on the preceding discussion, two Process Requirement controls are required to protect the assumption that criticality events are incredible. These controls are as follows:

- The total mass of fissile material in the facility shall be limited to 624 grams equivalent U-235.
- The number of fissile material cleanouts (partial or complete) credited with the removal of fissile material shall be limited to four per year.

## Low Energy Liquid Release (LELR)

### Background

An LELR can occur as a result of transfer errors, overflows, chemical addition errors, spills, leaks, or corrosion.

### Causes of Low Energy Liquid Release

Transfer errors in the facility can be attributed to procedural inadequacies and human mistakes associated with valve manipulations, piping errors, and premature or excessive transfers. Equipment failure can also lead to transfer errors.

The primary causes of overflows are valving errors, personnel difficulties, instrument failures, equipment failures, process control difficulties, and procedural difficulties. Overflows can be attributed to human errors (valving errors, procedural difficulties, etc.) or mechanical failures (instrument failure, leaky valve seats, etc.)

Chemical addition errors can result in a release through uncontrolled reactions/eructation's. An eructation, or burp-like release, is the result of an uncontrolled reaction. Uncontrolled reactions are normally caused by chemical addition errors that involve the transfer of an incorrect or unknown material into a vessel or the addition of an undesired quantity of material into a vessel. The primary causes of uncontrolled reactions/eructation's are operator error, valving errors, equipment failure, and procedural inadequacies.

Liquid spills may be caused by a valving error, seal/gasket rupture, or maintenance work. The contents of a drum of ash slurry are treated as a liquid and can be spilled as a result of a mechanical failure or operator error.

Leaks are caused by a wide variety of equipment failures and inadequate maintenance. The most common causes of leaks are valve failure, seepage through expansion joints, seal failure, gasket failure, inadequate tightening of fitting, loose flange, corrosion, and inadequate welds.

## Detection of Low Energy Liquid Release

Transfer errors are detected in processes by liquid-level indicators in vessels and sumps. operators observe depletion's in vessels from which contents are being transferred and increases in vessels receiving materials. Should substantial discrepancies in depletion or receipt occur, transfers are stopped until the discrepancies are resolved. Sump alarms are investigated to verify whether liquid is present in the sump or whether the indication is false.

Overflows are detected by liquid level detectors. High level detectors monitor liquid levels in sumps and vessels, and trigger an alarm when a level higher than the established instrument limit is reached. Alarms are investigated to verify whether the level is actually high or whether the indication is the result of instrument malfunction.

The chemical addition errors that can result in uncontrolled reactions/eructation's are detected primarily by material analysis and by liquid-level indicators installed in vessels. Operators observe the level indicators during the chemical addition of chemicals to a vessel. Should significant discrepancies in the level in the chemical storage vessel or the receiving vessel occur, the chemical addition is stopped until the discrepancies are resolved.

Spills are detected by level detectors or by operators in the area. Likewise, a leak will usually be detected by personnel in the area. However, in the event that a leak goes undetected by operating personnel, level detectors in the associated sump or radiation monitors will detect the leak. Continuous detection corrosion monitors are provided in all metal waste tanks. Continuous leak detection is provided on the OWTL.

## Frequency of Low Energy Liquid Release

The frequency of occurrence for low energy liquid releases at the CIF was determined by summing the individual historical frequencies for Building 211-F Outside Facilities. The frequency of occurrence for small low energy liquid releases is assumed to be 7.29E+01/year, while the frequency of occurrence for large low energy liquid releases is assumed to be 7.30E-02/year. The vast majority of the low energy liquid releases (roughly 99.9%) are small low energy liquid releases that involve less than 100 gallons.

The OWTL from DWPF is part of the tank farm. A low energy liquid release from the pipe jacket, which would result in consequences, is assumed to occur with a frequency of 1.00E-03/year. The maximum low energy liquid release from the pipe jacket, involving the total volume of the line, is considered an incredible event.

## Analysis of Consequences and Risk of Low Energy Liquid Release

Based on the fact that a small low energy liquid release involves only a fraction of the contents of a single vessel and evaporation produces a relatively small airborne release fractions, a small low energy liquid release in Segment 1 or 2 results in low consequences. Based on the high frequency of occurrence and very low consequences, this event represents a low risk.

Based on the fact that a large low energy liquid release involves, at the most, the contents of a single vessel and indicates the use of relatively small airborne release fraction, a large low energy liquid release in Segment 1 or 2 results in low consequences. Based on the medium frequency of occurrence and low consequences, this event represents a low risk.

## Natural Phenomenon

### Background

Extremes in natural phenomena can adversely affect operations within the 200 Area either by causing damage to equipment or by aggravating a deteriorated situation. Natural phenomena considered in the safety analysis include temperature, earthquakes, meteorites, volcanoes, and winds.

### Causes and Detection of Natural Phenomenon

The Site Characteristics section of the safety analysis provides a discussion of the causes and detection of natural phenomena.

### Frequency of Natural Phenomenon

The frequency of occurrence of natural phenomena which could adversely affect operations within the 200 Area vary widely with the type of phenomena. The frequency of occurrence of high-velocity straight winds is the greatest among the group with the frequency of exceeding 78 mph at SRS being 2.0E-02/year.

### Analysis of Consequences and Risks of Natural Phenomenon

Although difficult to quantitatively define, personnel effectiveness is reduced during very cold weather. Snow is not expected to damage CIF equipment directly but has been a severe aggravation during normal operation and maintenance of support facilities. Rain, flooding, and leaks can result in the spread of contamination and may also reduce the effectiveness of personnel. Lightning can result in the activation of spurious alarms and cause fires and damage to electrical equipment.

### Earthquakes

Based on the fact that an earthquake involves most, if not all, of the inventory in the facility and indicates the use of a relatively small airborne release fractions, this event results in medium consequences. Earthquakes, a design basis accident, having a low frequency of occurrence and medium consequences, represent a low risk. The CIF is designed to withstand earthquakes of .15g, exceeding the requirements for Radiological/Low Hazard facility structural design requirements of .11g.

## High Velocity Straight Winds

Based on the fact that high-velocity straight winds involves only a fraction of the inventory in the facility and indicates the use of a relatively small airborne release fractions, this event results in low consequences. Based on a medium frequency of occurrence and low consequences, this event represents a low risk.

# CIF PROCESS REQUIREMENTS

| | |
|---|---|
| **3.01** | **DESCRIBE** the function of the CIF Process Requirements**.** |
| **3.02** | **DEFINE** the following terms in accordance with the CIF Process Requirements:<br>a. Operable/Operability<br>b. Action<br>c. Surveillance Requirements (SR)<br>d. Immediately |
| **3.02** | **DEFINE** the following modes in accordance with the CIF Process Requirements:<br>a. Operation<br>b. Warm Standby<br>c. Shutdown<br>d. Cold Standby |
| **3.03** | **DETERMINE** the bases for equipment/conditions associated with CIF Process Conditions for Operations (PCOs). |
| **3.04** | **DETERMINE** required actions and associated completion times for given CIF conditions using the Process Requirements. |
| **3.05** | **DESCRIBE** the purpose and content of the Extended Authorization Basis Database. |

## Introduction

The Process Requirements is a WSRC document derived from the Auditable Safety Analysis and permit requirements which states the requirements for operating the facility. The Process Requirements is a "rule book" which must be followed in order to operate. We have committed to the DOE to operate according to the Process Requirements. The Process Requirements include the operating limits, the actions to be taken if the operating limits are not met, and the surveillance requirements which verify compliance with the operating limits.

If the facility has been deinventoried (i.e., wastes removed from process vessels and vessels rinsed), adherence to the requirements of the Process Requirements may be suspended by the Facility Manager. However, the facility may not receive any additional waste inventory until the Process Requirements are invoked.

The process requirements are divided into six major sections:

- SECTION 1 - Use and Application
- SECTION 2 - Process Limits
- SECTION 3/4 - Operating Limits and Surveillance Requirements
- SECTION 5 - Bases
- SECTION 6 - Administrative Controls

Section 1 contains basic information and instructions for using and applying the Process Requirements.

Section 2 contains Process Limits (PL) and Process Control Settings (PCS). This section would identify limits if exceeded that could directly cause a credible and significant uncontrolled release of radioactive or other hazardous material. The safety analysis did not identify any one single limit that could lead to this condition. Therefore there are no PL or PCS to prevent exceeding a process limit at CIF.

Sections 3 and 4 are combined. Section 3/4 contains specific Process Conditions for Operation (PCOs) and surveillance requirements (SRs) applicable to the facility. The PCSs and PCOs detail the actions to be taken when a particular limit is exceeded.

Section 5 provides for each Process Requirement a Bases that explains the background and applicability for the PL, PCS, and/or PCO, as well as the importance of the individual requirement to safety. More information may be found in the Extended Authorization Basis Database.

Section 6 contains the administrative and management controls necessary to ensure safe operation of the facility within the context of the Process Requirements. Inventory Control, the most critical process requirement, is found in section 6.5.10.

## SECTION 1.0 Use and Application

Section 1.0 contains basic information and instructions for using and applying the Process Requirements. The following topics are addressed:

- Introduction and Scope
- Definitions
- Operational Modes
- Completion Times
- Frequency Notations

## Introduction and Scope

The CIF Process Requirements are applicable to the operation and maintenance of the CIF.

## Definitions

A list of terms used throughout the Process Requirements and the associated definitions to be applied for these words. These terms appear in capitalized type throughout the Process Requirements.

## Operational Modes

Four operational Modes of the facility are defined in the Process Requirements. These Modes are Operation, Warm Standby, Shutdown, and Cold Standby.

### OPERATION

A Mode in which the Facility is capable of performing its intended function

### WARM STANDBY

A Mode in which the mission of the Process Area is not actively being performed. For the Incineration Area, waste feed burners are off and the kiln temperature is greater than 300 oF.

### SHUTDOWN

A Mode in which the Process Area is not operating. The Process Area is not permitted to receive solid or liquid wastes, but may retain its inventory of material. For the Incineration Area, kiln temperature must be at or below 300$^{o}$F.

### COLD STANDBY

A Mode in which the Process Area is not operating. The material is not allowed to receive material. The major part of the material inventory has been removed from the Process Area.

## Completion Times

The completion time is the amount of time allowed to complete a required action. Unless otherwise specified, the completion time is referenced from the time of discovery that a PCO has not been met.

When there are multiple actions required, each action and completion time must be separately considered.

A completion time of Immediately means the minimum amount of time required to complete the action in a safe manner.

### Frequency Notations

SRs are an integral part of the PCO and ensure proper compliance with the PCO. These surveillance's are performed on a frequency schedule as specified in the individual SR. The following table indicated each surveillance frequency and its meaning:

| Notation | Frequency |
|---|---|
| Hourly | At least once every 60 minutes |
| 4 Hours | At least once every 4 hours |
| Shiftly | At least once every shiftly |
| Daily | At least once every day |
| 2 Days | At least once every 2 days |
| 5 Days | At least once every 5 days |
| 7 Days | At least once every 7 days |
| 9 Days | At least once every 9 days |
| 12 Days | At least once every 12 days |
| 1 Month | At least once every 30 days |
| 3 Months | At least once every 90 days |
| 1 Year | At least once every 365 days |
| N/A | Not Applicable |

## SECTION 2.0 Process Limits

PLs are limits on process variables that, if exceeded, could directly cause a credible uncontrolled release of radioactivity or other hazardous material. The CIF Safety Analysis did not determine any one single limit that, if exceeded, could directly cause a credible release of radioactive or other hazardous material. Therefore, no PLs or associated PCSs are required.

## SECTION 3/4 Operating Limits and Surveillance Requirements

The Operating Limits and Surveillance Requirements section contains Process Control Settings (PCSs), Process Conditions for Operations (PCOs), and Surveillance Requirements (SRs) applicable to CIF. PCOs specify requirements for safe operation of the facility. PCS are settings for automatic alarm or protective devices related to those variables contained in the PCOs. Surveillance Requirements are requirements relating to a test or inspection to ensure that the necessary operability of systems, subsystems, components, or devices is maintained and that operations are within the specified PCOs. PCOs shall be met for all modes specified in the individual PCOs.

Each PCO has the following information associated with it:

- PCO statement
- Mode Applicability
- Process Area Applicability
- Actions
- Surveillance Requirements

The Actions Section associated with a PCO lists ways in which the requirements of the PCO can fail to be met. One or more actions and associated completion times are specified with each stated condition.

Sections 3.0, containing PCOs 3.01 through 3.06 contain general guidance associated with the specific Section 3 PCOs. Upon discovery of a failure to satisfy a PCO statement, the Action(s) associated with the appropriate Condition(s) shall be entered. To satisfy the actions the Required Action(s) must be performed within the associated completion times. The completion time is the amount of time allowed for completing an Action. The completion time begins when the PCO condition is discovered as not being met (e.g., inoperable equipment or variable is not within its allowed limits), provided the facility is in a Mode or specified condition stated in the Applicability Section of the PCO. A condition remains in effect, and the actions apply until the condition no longer exists, or the Process Area is not within the PCO Applicability.

If situations are discovered that require entry into more than one condition at a time within a single PCO (multiple conditions), the actions for each condition must be performed within the associated completion time. When in multiple conditions, separate completion times are tracked for each condition, starting from the time of discovery of the situation that required entry into the condition.

In some cases, “Immediately” is used as a special completion time. There is not a definitive time frame associated with “immediately.” However, the actions using “immediately” as a completion time shall be pursued without delay and continued until the action is completed. Use of “immediately” implies the highest priority for completion. It is important to be aware of any actions which are required to be performed immediately.

Like section 3.0, section 4.0 contains general guidance associated with the specific Surveillance Requirements. SRs shall be met during all modes specified for the particular PCO, unless otherwise stated in the individual SR. The interval for each SR is met if the SR is performed within 1.25 times the interval specified in the frequency, as measured from the previous performance. For example, the interval for a 4 hour surveillance will be considered to be met if a given surveillance was completed within 5 hours of its last previous completion. This allowance is not applicable to conditional SRs. Failure to meet an SR within the specified frequency constitutes a failure to meet the PCO.

## SECTION 5 Bases

The Bases section provides for each Process Requirement a Bases that explains the background and applicability for the PL, PCS, and/or PCO, as well as the importance to safety of the individual requirement to safety.

## SECTION 6 Administrative Controls

The Administrative Controls section contains the administrative and management controls necessary to ensure safe operation of the facility within the content of the Process Requirements. It also provides an overview of control documents and programs used to maintain safe operations.

The control documents and programs for the CIF are prescribed to ensure that basic and important decisions are made only after review and that decisions, which could significantly affect safety, receive the appropriate review.

An important part of the Administrative Controls section is Section 6.5.10, Facility-Specific Programmatic Controls. Included in this section is the guidance associated with the CIF Inventory Control Program.

Section 6 is divided into the following sections:

- Introduction
- Organization
- Management Responsibilities
- System of Control Documents
- Description of Controls
- Events, Conditions, and Concerns Investigations and Occurrence Reporting
- Reviews and Assessments
- Qualifications and Training
- Facility Operating Records

## CIF Extended Authorization Basis Database

A relational database, referred to as the Extended Authorization Database (EAB), has been created and implemented for the CIF. The EAB will facilitate information searches concerning hardware, safety and regulatory requirements, administrative procedures, and other sources. Informally called the "knowledge cube" the EAB is designed to capture and maintain all of the information considered to be important for the safe operation of CIF.

The EAB software can facilitate many information searches to aide personnel assigned to and supporting CIF. While the EAB is a relational database that can be programmed to execute many functions, it is built around a select set of "parameters" important to CIF. These parameters are requirements considered vital to the safety of the facility operations. Facility personnel reviewed key source documents such as the Auditable Safety Analysis (ASA), Process Requirements (PR), and environmental permits in order to identify parameters by which the CIF must adhere to during its operation.

## Linkage

As the EAB is a relational database, linkage of the various databases is essential for consistency, accuracy, and proper interfacing. For parameters related to plant hardware, applicable Component Location Identifiers (CLIs), unique numbers that identify the specific process location of a component, were referenced, or linked, to that parameter. If a parameter was applicable to two or more components, it was linked to each component. For those parameters not related to plant hardware, an Administrative Linking Identifier (ALI) was created and assigned by the EAB Team.